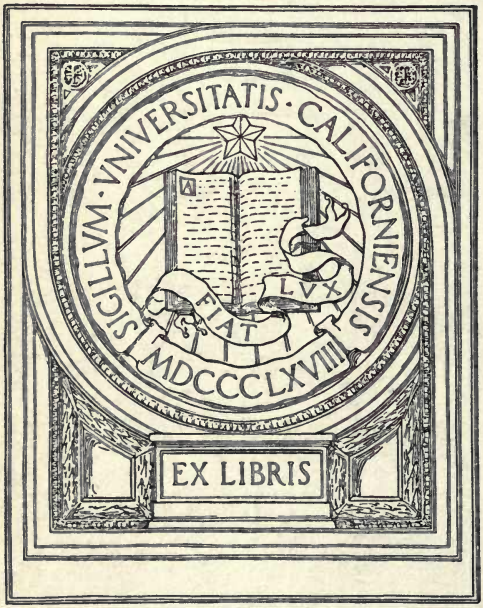
EXCHANGE


SIGILLVM · VNIVERSITATIS · CALIFORNIENSIS
LVX
FIAT
MDCCCLXVIII
EX LIBRIS

MONTHLY BULLETIN

OF THE STATE COLLEGE OF WASHINGTON

PULLMAN, WASHINGTON

Vol. 4 FEBRUARY, 1922 Number 9

Water Purification
for the
Country Home

By M. K. SNYDER
Municipal and Sanitary Engineer

ENGINEERING BULLETIN No. 10
Engineering Experiment Station
H. V. CARPENTER, Director

1922

Entered as second-class matter September 5, 1919, at the postoffice at Pullman, Wash., under Act of Aug. 24, 1912

The ENGINEERING EXPERIMENT STATION of the State College of Washington was established on the authority of the act passed by the first Legislature of the State of Washington, March 28th, 1890, which established a "State Agricultural College and School of Science," and instructed its commission " **to further the application of the principles of physical science to industrial pursuits.**" The spirit of this act has been followed out for many years by the Engineering Staff, which has carried on experimental investigations and published the results in the form of bulletins. The first adoption of a definite program in Engineering research, with an appropriation for its maintenance, was made by the Board of Regents, June 21st, 1911. This was followed by later appropriations. In April, 1919, this department was officially designated, Engineering Experiment Station.

The scope of the Engineering Experiment Station covers research in engineering problems of general interest to the citizens of the State of Washington. The work of the station is made available to the public through technical reports, popular bulletins, and public service. The last named includes tests and analyses of coal, tests and analyses of road materials, testing of commercial steam pipe coverings, calibration of electrical instruments, testing of strength of materials, efficiency studies in power plants, testing of hydraulic machinery, testing of small engines and motors, consultation with regard to theory and design of experimental apparatus, preliminary advice to inventors, etc.

Requests for copies of the engineering bulletins and inquiries for information on engineering and industrial problems should be addressed to Director, The Engineering Experiment Station, State College of Washington, Pullman, Washington.

The Control of the Engineering Experiment Station is vested in the Board of Regents of the State College of Washington.

BOARD OF REGENTS

Hon. Louis F. Hart, Governor of the State,	Olympia
R. C. McCroskey	Garfield
Adam Duncan Dunn,	Wapato
Edwin A. Ritz,	Walla Walla
A. W. Davis,	Spokane
J. H. Hulbert,	Mt. Vernon

E. O. Holland, Secretary Ex-Officio, President State College Pullman

---

ENGINEERING EXPERIMENT STATION STAFF

Director, ... H. V. Carpenter, B. S., M. S.
Experimental Engineering, ... Homer J. Dana, B. S., M. S., M. E.
Electrical Applications, ... Philip S. Biegler, B. S., M. S., E. E.
Electrical Standardizations, ... Harry F. Lickey, B. S.
Automotive Engineering ..... Aschel C. Abell, B. S.
Steam Engineering, ... A. R. Nottingham, M. M. E.
Mechanical Design, ... E. B. Parker, B. S.
Engineering Materials, ... G. Everett Thorton, B. S.
Gas Power, ... William A. Pearl, B. S.
Steam Power ..... Robert L. Rhoads, M. S.
Mining Engineering, ... Louis O. Howard, A. B., M. E.
Metallurgical Engineering ..... Chester G. Warfel, M. E.
Economic Geology, ... Olaf P. Jenkins, A. B., A. M.
Irrigation and Structures, ... Osmar L. Waller, Ph. B., Ph. M.
Municipal Engineering ..... Morris K. Snyder, B S.
Highway Engineering, ... Howard E. Phelps, B. S., C. E.
Topographical Engineering, ... Frederic W. Welch, B. S., C. E.
Architectural Engineering, ... Rudolph Weaver, B. S.
Agricultural Engineering, ... L. J. Smith, B. S.
Physics, ... Brenton L. Steele, B. A., M. A.
Chemical Engineering, ... Clare Chrisman Todd, B. S., Ph. D.

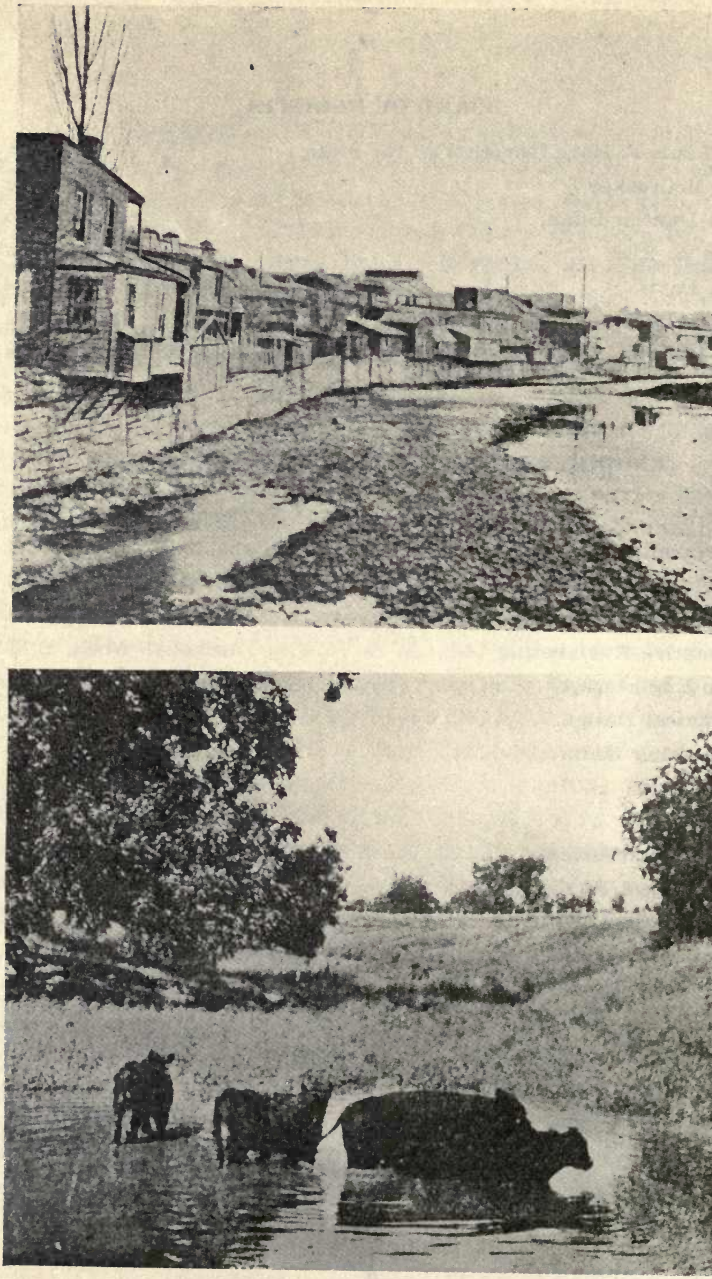


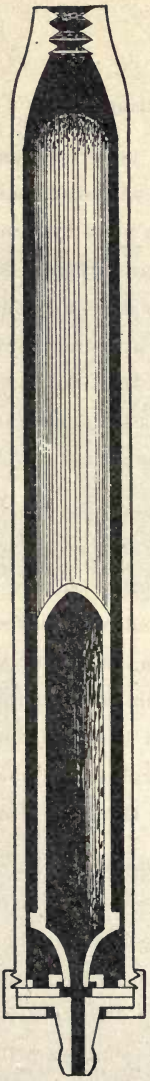
Fig. 1. Polution of Ponds and Streams

Introduction

The farmstead, being the source of supply of the food of the world, deserves to have special attention paid to its needs. Of these needs, few are greater than the need for pure water. It would seem that farming regions, which are usually remote from the thickly settled districts, would find no difficulty in securing such a supply. But we find that many of our intestinal diseases, such as diarrhoea, dysentery, typhoid fever, and the like, are more prevalent in the country than in the city. This can mean but one thing—the farming community is very careless about its water supply.

The germs of these diseases may be distributed, disseminated and carried long distances by water or by milk and vegetables which have been contaminated by water. These diseases are also spread over restricted areas by flies and other insects which breed in refuse and filth. It would seem, then, that the vital problems confronting the farmer are (a) the problem of securing a water supply that is sufficient in quantity and that is at all times safe and wholesome, and (b) the closely related problem of the careful and economical disposal of the wastes in which flies breed and on which they feed.

The importance of pure water for drinking has been repeatedly demonstrated. Disease is frequently traced to the use of impure water from wells polluted by cess-pools, barnyard seepage, or other sources of impurities. The water may be clear, ordorless and tasteless and still contain dangerous disease germs. In such case, only a chemical and a bacteriological analysis will reveal the danger, and such an analysis should always be secured if the water is at all doubtful. Such an analysis, costing but a small part of a doctor's bill, to say nothing of the discomfort to the sick one, will enable the user to tell whether purification is necessary.



Pasteur Filter

Fig. 1

In other cases, the pollution is evident from the color, taste, or odor of the water and from these alone it will be known that precautions are necessary.

Purification of Water

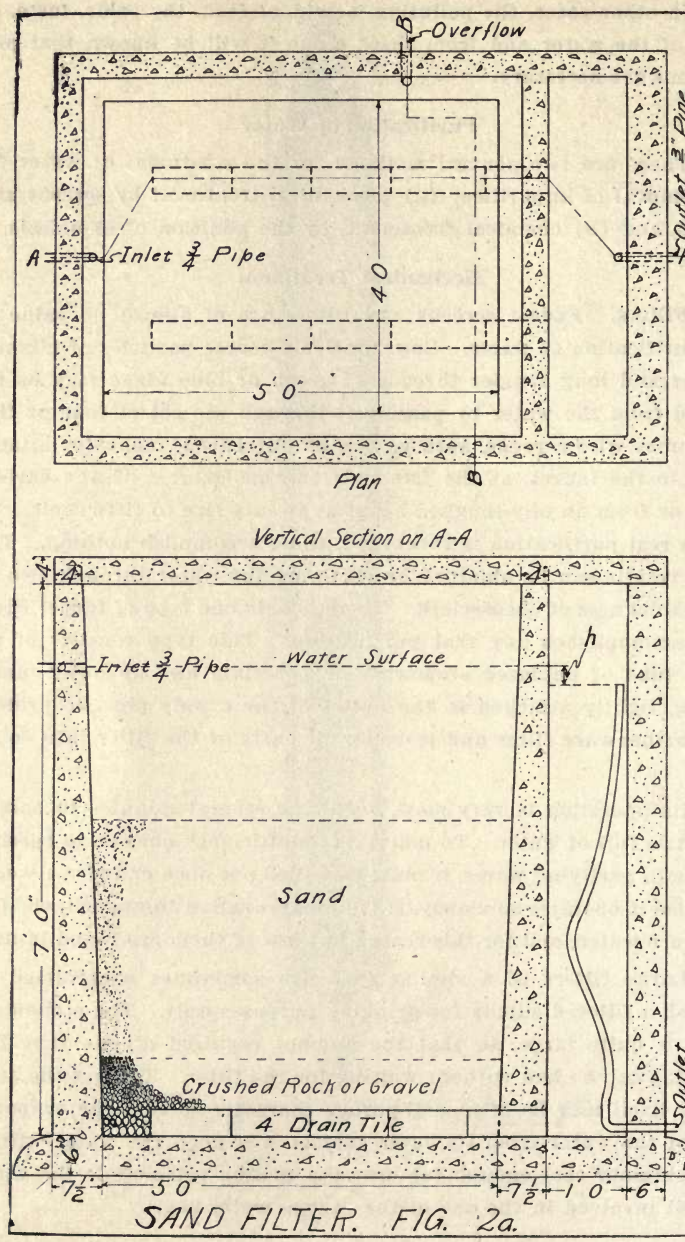
There are two general methods for the treatment of water for the removal of impurities; (a) mechanical treatment by screens and filters, and (b) chemical treatment, by the addition of chemicals.

Mechanical Treatment

Filters. Faucet screens and filters are of almost no value in the purification of water. Comparatively coarse particles of mineral matter and long slender threads of green or blue algae may be removed from the water by passing it through the set of four or five fine brass wire screens, such as can be purchased, ready for attachment to the faucet, at the five-and ten-cent counter of any variety store or from an oily-tongued agent at twenty-five to fifty cents. So far as real purification is concerned, **these accomplish nothing.** The same results can be obtained by straining the water through two or three thickness of cheesecloth. There is only one type of faucet filter that accomplishes any real purification. This type consists of an inner tube of unglazed stoneware or porcelain and an outer metal casing, tightly attached to the outlet of the supply pipe, to protect the earthenware filter and to bring all parts of the filter into equal use.

Its operation is very slow, requiring several minutes to pass a teakettle full of water. To maintain its efficiency both as to passing and as to purifying water, it must be boiled out once or twice a week. Because it operates so slowly, it is an aggravation to anyone wishing to secure water, and for this reason but few of them are found in use.

Large filters of a similar type are sometimes constructed to furnish a filtered supply for drinking purposes only. The stoneware filter is quite large, so that the amount required at one time for drinking can be had without waiting for the filter. The outside container itself may be of a semi-porous character so that the evaporation of the water from its outer surface will keep the water within the container cool enough for use; the cooling principle is the same as that involved in the use of the canvas water-bag.



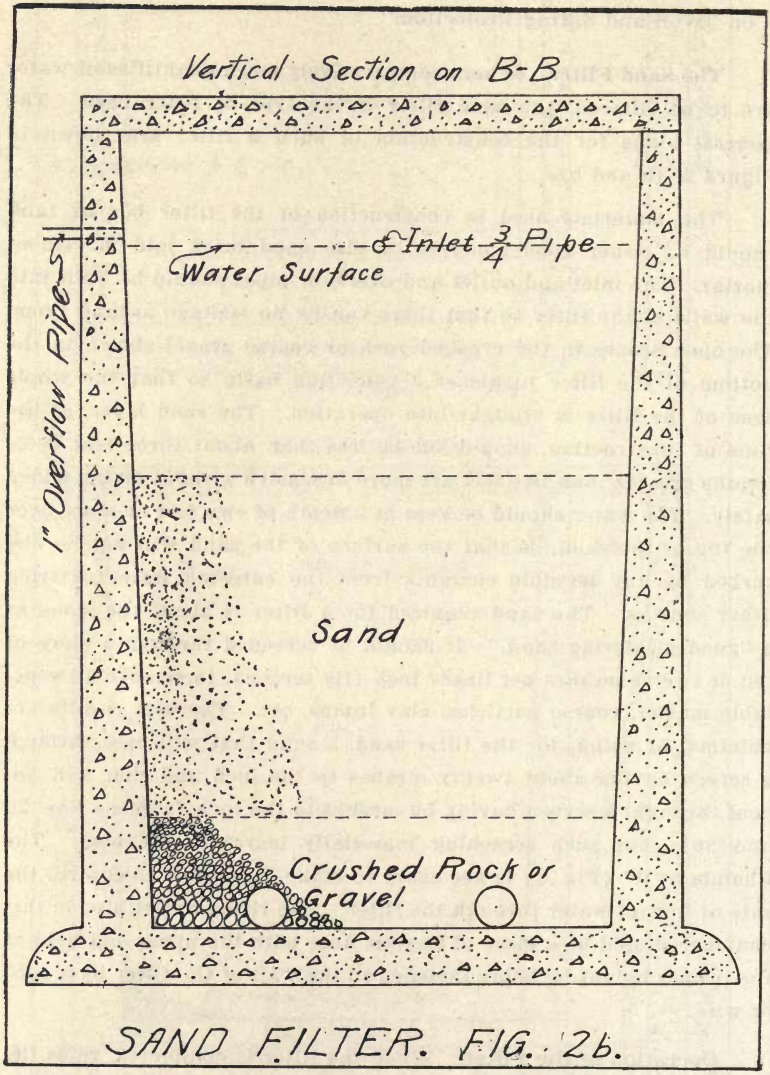
SAND FILTER. FIG. 2a.

If the supply is taken from a well and requires to be filtered as described above to insure its wholesomeness, the best treatment is that suggested in the paragraph on "Safety Distance" in Bulletin No. 9 on "Well and Spring Protection."

The Sand Filter. Where comparatively large quantities of water are to be filtered, the sand filter is the type of filter used. The general plans for the construction of such a filter are shown in Figure 2. (a and b).

The materials used in construction of the filter box or tank should be either good concrete or else good brick laid in cement mortar. The inlet and outlet and overflow pipes should be built into the walls of the filter so that there can be no leakage around them. The open spaces in the crushed rock or coarse gravel shown in the bottom of the filter furnishes a collecting basin so that the whole area of the filter is brought into operation. The sand layer, at the time of construction, should not be less than about three feet deep. Depths greater than five feet are more expensive without giving added safety. The water should be kept at a depth of two feet or more over the top of the sand, so that the surface of the sand will not be disturbed by any possible currents from the entering water or from other sources. The sand required for a filter is about the same as a "good plastering sand." It should be screened through a sieve of ten or twelve meshes per linear inch (fly screen), to remove all vegetable matter, coarse particles, clay lumps, etc. The best results are obtained by using, for the filter sand, a sand that will pass through a screen having about twenty meshes to the inch and that will not pass throught a screen having 50 meshes to the inch (screens Nos. 20 and 50); but such screening materially increases the cost. The Chamber "B" (Fig. 2) is necessary to make it possible to control the rate of flow of water through the filter. The rising outlet pipe in this chamber should be a piece of flexible hose with the upper end held at the proper height by being fastened to the wall of the filter by a cord or wire.

Operation of the Filter. When the filter is completed, raise the end of the rubber hose above the level of the inlet pipe; then fill the filter with water, taking care to disturb the surface of the sand as



SAND FILTER. FIG. 26.

little as possible. Now, lower the end of the hose about one and one-half inches below the level of the inlet; turn on the water in the inlet pipe and the filter is in operation. The water passing through the filter for the first two or three days should be allowed to waste, after which time it may be turned into the cistern or reservoir. The filter gives best results when operating continuously at a fixed rate. To make this possible, the reservoir or cistern should be provided with an overflow.

The rate of operation should be about fifty gallons per square foot per day. The head "h" (Fig. 2) required to pass this quantity of water will vary with the sand used and with the length of time the filter has been in operation. When the filter is new or has just been cleaned, "h" should not be over two inches; after a month or more service it may be twenty inches. Th filter should then be cleaned.

Cleaning the Filter. Close the inlet pipe and draw off the water from the filter. With a square pointed shovel or similar instrument, carefully remove the upper one-half or three-fourths inch of sand. Then fill the filter with filtered water, if possible, pouring the water into the filter through the discharge chamber. When the filter is full, open the inlet pipe, set the end of the discharge pipe just below the level of the inlet, and the filter is in operation again. If the filter is filled with raw water, the flow for two or three days must be wasted, as previously described.

Size Required. If the house is not provided with pressure water. but all water has to be pumped from the cistern, as used, the domestic use will average from ten to fifteen gallons per person per day. If the house is provided with pressure water and fitted with bath, toilet and other conveniences which go with pressure water, the use will be from thirty to fifty gallons per person per day. Taking all kinds of stock into consideration, the use will be about six gallons per head per day in winter and about sixteen gallons per head per day in summer. Using the average of the above figures and assuming that water must be stored for use for one-half of the year, a family of five people having twenty head of stock will require per day as follows:

Use	Regular	Storage	Total	Size of Filter Required at 50 Gal. per sq. ft. per Day
When pumping water from cistern as used				
Family use	60 gal.	60 gal.	120 gal.	
Stock use	220	220	440	
Waste	20	20	40	
			600 gal.	3 ft. x 4 ft.
With Pressure Water:				
Family use	200	200	400	
Stock use	220	220	440	
Waste	80	80	160	
			1000 gal.	4 ft. x 5 ft.

The waste from leaks in pipes, etc. in pressure water systems is usually quite large.

Modifications can be made in the above for different quantities of stock and a different number in the family.

Construction. The filter tank may be constructed of any material that is not subject to rapid decay. Occasionally we find one built of wood painted with asphaltic paint. Often they are built of brick laid in cement mortar but the best material to use in their construction is concrete. The concrete should be a rich mixture—one part cement to two parts sand to four parts crushed rock or gravel. The crushed rock or gravel should contain no stones larger than one and one-half inches in greatest dimension. Rounded stones screened from gravel will be found to work better than the sharp angular ones of crushed rock. The concrete should be well tamped as it is placed in the forms.

If possible, when constructing the filter tank of concrete, the excavation should be made just equal to the outside dimensions of the tank, the side of the excavation being used for the outside forms. The bottom of the excavation is carefully smoothed to the desired shape. The forms for the side walls and the division wall are set first and these walls are put in first. At the same time, the inlet and outlet and overflow pipes are carefully set in their proper places. Some concrete should be allowed to crowd out at the bottom of the wall forms, so that the bottom of the tank, which is next put in place, will have a good bond to the side walls.

After a few days the forms are removed and the interior of the tank plastered with a mortar consisting of one part cement to one

part sand, the walls being thoroughly wet before the mortar is put on. Whenever fresh concrete is to be joined to that which is set, the surface of the old concrete should be thoroughly cleaned and wet and covered with mortar before the fresh concrete is put in place.

A good concrete slab cover is preferable but a well made wooden cover will serve very well.

Chemical Treatment

There are a great many different chemicals used in the purification of water, but most of them require an expert operator to apply them so as to get results. Some others are so injurious to health that they may be used only in carefully determined quantities and by a skilled chemist. Leaving these two classes out of consideration, we have only one or two chemicals which are available for use on the farm.

Hypochlorite Process. For the destruction of all dangerous bacteria which may be in the water ,nothing equals in efficiency and convenience ordinary Chloride of Lime. This may be obtained from almost any grocery store in small cans costing but a few cents and the amount required is so small as to make the cost almost negligible. It should be used in the following manner:

One tablespoonful of the Chloride of Lime is dissolved in ten quarts of water. This quantity is sufficient to treat 1000 gallons of water, and the operation is carried out by simply pouring the clear solution into the water to be treated and stirring thoroughly. This solution is a powerful germicide and its action is very rapid, ten minutes or so being all the time required to carry out the purification. One quart of this solution is sufficient to treat effectively a tank containing 100 gallons of water, and one pint of it stirred into a 50-gallon barrel full of water will destroy any dangerous germs and make the water safe for drinking purposes.

One is cautioned against using too much of the chemical, not because it is dangerous at all, but because an undesirable odor or taste may be imparted to the water when too large amounts are used. The strength of solution indicated above, used in the manner described, will be found perfectly satisfactory. The qualities of the

water will be in no wise impaired and no undesirable conditions will arise from its use. On the other hand, dangerous water may be made safe and much sickness prevented.

The solution loses its strength if left standing open for any time but may be kept for several days in a tightly stoppered bottle. If so kept, it becomes a very handy germicide to use during the harvesting and threshing season. The water used about the cookhouse and for drinking purposes in the field and about the threshing machine can be made safe and the amount of typhoid fever and other intestinal trouble made much less.

Lime Process. Lime is sometimes used for purification of water. About two or three pounds of quicklime is required for 1000 gallons of water. If the water is very hard, a large amount must be used. The quicklime is slacked in a pail of water and is then added to the cistern or reservoir full of water and stirred in thoroughly. The action of lime is much slower than that of the Chloride of Lime, as the former requires about 24 hours to sterilize the water. The chief difficulty in the use of lime is the accumulation of sediment in the bottom of the reservoir due to the settling of the lime. The bulk of sediment is many times the bulk of the lime used and frequent cleaning is necessary. The hypochlorite treatment is recommended rather than lime treatment.

ENGINEERING BULLETINS PUBLISHED BY THE STATE COLLEGE OF WASHINGTON ENGINEERING EXPERIMENT STATION.

1. Sewage Disposal for the Country Home.
   Septic tanks and underground distribution systems.
   By O. L. Waller and M. K. Snyder. Mar. 1914, July 1916.

2. How to Measure Water.
   Construction of weirs and tables for same.
   By O. L. Waller. Oct. 1915.

3. Water Supply for the Country Home.
   Water Sources, pumps, filters, storage tanks and cost data.
   By M. K. Snyder.

4. Construction and Maintenance of Earth Roads.
   Grades and grading, drainage and dragging.
   By L. V. Edwards. April 1916.

5. Cost of equipment and operation of same, with tables of efficency.
   By O. L. Waller. Aug. 1916 (out of print).

6. Fuel Economy in Domestic Heating and Cooking.
   Fuel Tables, heating equipment and care of same.
   By B. L. Steele. Dec. 1917.

7. Thawing Frozen Water Pipes Electrically.
   Method of Thawing and list of equipment needed.
   By H. J. Dana. Oct. 1921.

8. The Use of Ropes and Tackle.
   Illustrations of application to diffrent jobs.
   By H. J. Dana and W. A. Pearl. Dec. 1921.

9. Well and Spring Protection.
   By M. K. Snyder. Jan. 1922.

10. Water Purification for the Country Home.
    By M. K. Snyder. Feb. 1922.

11. Farm Water Systems.
    By M. K. Snyder and H. J. Dana. (In preparation).

12. Commercial and Economic Efficiency of Commercial Pipe Coverings.
    By H. J. Dana. (In preparation).

The
State College of Washington

Founded and Maintained by the National Government and the State of Washington

---

College of Agriculture and Experiment Station
Farm Crops, Soils, Animal Husbandry, Dairy Husbandry, Poultry Husbandry, Horticulture, Landscape Gardening, Forestry, Farm Management, Plant Pathology, Agricultural Engineering.

College of Mechanic Arts and Engineering
Architecture, Civil Engineering, Electrical Engineering, Hydro-Electrical Engineering, Mathematics, Mechanical Engineering, Physics.

College of Sciences and Arts
Chemistry, Chemical Engineering, Botany, Zoology, English, Economic Science and History, Foreign Languages.

College of Home Economics

College of Veterinary Science

School of Mines and Geology
Geology, Mining, Metallurgy, Metallography.

School of Education

School of Music and Fine Arts
Music, Oral Expression, Dramatic Art, Fine Arts.

School of Pharmacy

The Graduate School

Department of Military Science and Tactics

Department of Physical Education and Athletics

The Summer Session (six weeks)

Short Courses from one to twelve weeks, beginning early in January, are offered in Farming, Gas Tractors, Automobiles, Home Economics, and Mining.

The Department of Elementary Science offers three-year vocational courses in agriculture, horticulture, mechanic and industrial arts, commerce, and domestic economy, from which young men and women can, if they desire, be admitted to the Freshman class of the College.

The College Year Begins Monday, September 18, 1922.

Address all inquiries to:

THE REGISTRAR, Pullman, Wash.

Extension Service, under the Smith-Lever Act, is in charge of the demonstration and correspondence work in Agriculture, Home Economics, Boys and Girls Club Work, and County Work.
Address: **The Director.**

The Division of General College Extension gives correspondence courses, organizes extension classes, supplies lectures and educational motion picture films.
Address: **Director.**

MANY DEPARTMENTS PUBLISH SPECIAL BOOKLETS

UNIVERSITY OF CALIFORNIA LIBRARY

14 DAY USE
RETURN TO DESK FROM WHICH BORROWED

LOAN DEPT.

RENEWALS ONLY—TEL. NO. 642-3405
This book is due on the last date stamped below, or
on the date to which renewed.
Renewed books are subject to immediate recall.

RECEIVED
DEC 15 '68 - 2 PM
LOAN DEPT.

OCT 25 1969 1 4
REC'D LD NOV 5 '69 -4 PM

MAY 12 1972 5 1
REC'D LD MAY 4 7? -12 AM 1 7

MAR 6 1975 9 9
April 6, 1975
REC. CIR. APR 5 '75

AUG 26 1999

LD 21A-38m-5,'68
(J401s10)476B

General Library
University of California
Berkeley

945265
TA1
W27
no. 7-24
THE UNIVERSITY OF CALIFORNIA LIBRARY